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The QUARTERLY REVIEW

Published by the

American Electro-Platers Society

A SOCIETY FOR THE ADVANCEMENT

OF THE

SCIENCE OF ELECTROPLATING

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VOL. XIX OCTOBER, 1932 No. 8

Afterthought

During the meetings of the Executive Board and the business sessions of the Philadelphia Convention, the Supreme officers received several criticisms from members in different branches of our organization. All of these were offered by those who have the best interests of the Society at heart, and, as such, they are taken in the kindly spirit in which we believe the criticisms were given.

It must be remembered, however, that we are a growing and progressive body. We cannot stand still and live in the past. Just because we followed a certain course of action when we first organized is no reason why we should not occasionally deviate from the beaten path when necessity requires it.

The Constitution of our country has been amended many times since that great document was first presented to Congress for approval, and in like manner we are compelled to change our method of doing business to keep abreast of the times.

Our monthly publication was the principal topic of discussion at some of the meetings, and because of the depleted state of the treasury, it was voted to reduce the number of editions published from twelve to four per year. This was a distinct step backward, and is atoned for only by the fact that we are passing through a period of economic and industrial depression, which has had its effect on the earning power of our entire membership. This condition is only temporary, however, and is not confined to ourselves alone. We believe that the dark clouds of unemployment and discouragement will soon be driven from our industrial horizon and that happy days will be here again before long.

To this end our President is busy selecting committees to work

with him in solving the many problems now confronting us. Knowing Mr. VanDereau, we can visualize the type of men he will appoint; and it's safe to predict that when the 1933 convention meets in Chicago our Society will be placed on a stronger and safer foundation than ever before. Meanwhile it is our privilege to attend faithfully to the tasks allotted to us as members of the A. E. S.

Let us not be weary in well doing, for in due time we shall reap if we faint not.

1932 PHILADELPHIA CONVENTION REPORT

In making this report it will not be amiss to write a short résumé in connection with it, in as much as it may be of some help to the smaller branches desiring to hold a convention in their city. Realizing that conditions differ in the various branch cities, still we believe small branches need not hesitate in having a convention in their city.

Philadelphia Branch this year, during a business depression, ran their convention more as an experiment to prove to the smaller branches that a good Educational Convention can be financed with a $1.00 registration and *no* paid advertising program. After reading the financial part of this report, you can readily see how economical a convention can be run, and with the smallest registration in the Society's history, still we were able to clear a profit of about $100 and without making use of the $150 donated by the Rochester Branch.

We know from past experience that large and influential branches, with a large registration fee and an advertising program, can do a lot of entertaining and also make a large profit from such a convention and, as some of our members have remarked, the entertaining features of the conventions are becoming more important to convention committees than the educational program. Realizing that this is not what the members and guests have in mind when they attend a convention, we therefore tried our best to have the best educational papers and speakers that could be had and that would be of the most interest to the electroplater and the electroplating industry, and left the entertaining for one night at least to the International Fellowship Club.

From experience gained trying to get educational speakers and

papers, we believe a committee of the Supreme Officers could do a great deal better and are in a better position to get nation-wide papers and speakers than a local committee could do, and we recommend to the Supreme Officers that they give this some consideration so some action can be taken at the Chicago Convention.

The Supreme Secretary has the complete proceedings of the convention mimeographed in one volume, containing all the papers and discussions and also the entire business sessions of the conventions, and every plater should have a copy of the same. The Supreme Secretary has a few copies left and the same can be had for $3.50 per copy plus postage. Write him at once before they are all gone.

We take this opportunity of thanking all those who attended the convention, and those who worked so hard and assisted us in making the educational program a success. We also extend our thanks to the International Fellowship Club for the Prizes and the Open House night furnished the guests of the convention. We also extend our thanks to the Reynolds-Robson Co. of Philadelphia, and the Matchless Metal Polish Co. of Glen Ridge, N. J., for the fine programs furnished the convention.

RECEIPTS

Donation received from Rochester Branch	$150.00	
292 Registrations @ $1.00 each	292.00	
128 Bus tickets @ $0.35 each	44.80	
184 Banquet tickets @ $3.50 each	644.00	
Total		$1130.80

EXPENDITURES

Printing	$ 50.38	
Postage	39.80	
Renting typewriters	4.00	
Renting lantern	5.00	
Signs painted	8.00	
Badges	120.00	
Favors for banquet	45.00	
Music for banquet	42.00	
Talent for banquet	30.00	
Hotel dinner per cover $2.50	488.00	
Busses	44.80	
Total		$ 876.98
Profit		$ 253.82

Respectfully Submitted for the Committee,

GEORGE GEHLING, *Director.*

Awards for Papers at the Philadelphia Convention

The Prize Award Committee did not make any award for educational papers, due to the fact that no papers were received from active members of the Society which merited such award.

The following associate members contributed papers receiving honorable mention:

W. M. PHILLIPS for his papers on "Low pH Nickel Solutions" and "Pitting of Nickel."

GUSTAF SODERBERG for a paper on "Anode Phenomena in Cadmium Plating Solutions."

GEORGE DUBPERNELL for a paper on "Causes of Adhesion of Electrodeposits."

GEORGE B. HOGABOOM for his paper on "Electroplating on Cold Rolled Steel."

These papers were published in THE MONTHLY REVIEW during the past year.

Exhibits

FIRST PRIZE CERTIFICATE for an exhibit of plating was awarded to W. W. Feltin of the Samson United Company, Rochester, N. Y., for his exceptional display of work.

IMPORTANT ANNOUNCEMENT

Attention Electroplaters:

The Chicago Branch of the American Electro-Platers Society extended an invitation to the Supreme Society to hold their annual meeting of 1933 in Chicago. This invitation was accepted and Chicago was selected as the 1933 Convention City. Chicago Branch immediately took off their coats, rolled up their sleeves and started to work, and it is going to be a great pleasure for the boys of the Chicago Branch to serve the Supreme Officers, delegates, members and visitors who attend.

Besides the many advantages which Chicago offers as a great convention city, we are most fortunate in having as an added attraction the *Century of Progress Exposition* which is held in observance of the Centennial of Chicago, and will open June 1, 1933. This Exposition will tell by easy stages and in simple form, the story of scientific discoveries and inventions, their application to industry and the resultant transformation that has made the world of today so different from the world of a century ago.

This *Century of Progress* applies directly to all of those who are today engaged in the Art of the Electro-Deposition of Metals, due to the fact that in 1833 a great scientist made a discovery in his basement laboratory in England, which is the foundation that made possible the production and control in the plating industry of today. Therefore, the year 1933 is the 100th Anniversary of the discovery made by Faraday and known as "Faraday's Law." This discovery that the amount of disassociation of any metal is in direct proportion to the amount of current passing through the electrolite, was the beginning of what is today the Plating Industry. Platers, and all those associated directly or indirectly, in the industry, owe very much to the genius of Faraday; and to show this appreciation in a small way the Chicago Branch of the American Electro-Platers have arranged with Dr. I. E. Muskat of the Basic Science Division, *Century of Progress Exposition,* to declare and dedicate Wednesday, June 28, 1933, as "FARADAY DAY," and arrangements are being made to hold suitable exercises in the Science Building. An eminent scientist from England will deliver the principal address to the visitors at the Convention and will tell us of Faraday as a scientist and what were his accomplishments. Chicago Branch is happy to honor one who really is responsible for our means of livelihood today.

The Convention Headquarters will be located in the Congress Hotel, which is one of the best hotels in Chicago and is located on beautiful Michigan Avenue, overlooking Grant Park and in the near distance grand old Lake Michigan. It is only a short walk to the main entrance of the World's Fair Grounds. Directly across the avenue is a beautiful esplanade with walks leading directly to the world-famous Buckingham Fountain, all of which is visible from the hotel rooms. This fountain, shooting hundreds of streams of water, some as high as 150 feet in the air, with a constantly changing colored lighting effect, is a gorgeous sight. The Congress Hotel is, in appointments, second to none, and its management are noted for their courteous treatment and cheerful service and their cuisine is famous the world over.

To better acquaint you with the character of Chicago and what are its advantages as a Convention City the Committee have arranged a series of eight articles with illustrations which will be published monthly between the present time and the opening of the 1933 A. E. S. Convention. The subjects are as follows:

November—General History and Growth of Chicago.
December—Chicago as an Industrial Center.
January—Chicago as a Transportation Center.
February—Chicago Park and Boulevard Systems.
March—Chicago as a Health and Summer Resort.
April—History of Chicago Branch A. E. S.
May—Century of Progress Exposition.
June—Program and Description of Events.

The dates selected for the 1933 Convention are June 27, 28, 29 and 30—Tuesday, Wednesday, Thursday and Friday. These dates were selected so that members, delegates and visitors will have ample time after the close of business, Saturday, June 24, to reach Chicago by Tuesday, June 27, either by auto, train or boat; and after the close of the Convention it will allow Saturday, Sunday and Monday to visit the Exposition and reach home by July 5.

Owing to the large number of visitors in Chicago and the large number of conventions held during the time we selected, the Committee wishes to urge all delegates, members and visitors to make the Congress Hotel their home as well as their headquarters while in Chicago. This will keep us all together and help the Committee to serve you with a maximum of efficiency and mutual benefit. Make the Congress your home with Chicago Branch as your host.

One fact the Committee wishes indelibly to impress upon each member of the American Electro-Platers Society, is that you cannot afford to miss this Convention. The articles before mentioned which will be published monthly will tell you facts about Chicago, the A. E. S. Convention and the *Century of Progress* World's Fair which will prove the statement that you cannot afford to stay away from the A. E. S. Convention in 1933. Start your Convention Savings Fund right now and be prepared when the time comes to take advantage of Chicago's hospitality with its unsurpassed features for your education and entertainment.

Chicago, the great metropolis of the Middle West.
The American Electro-Platers Convention.
The Century of Progress Exposition World's Fair.
Faraday Day, June 28, 1933. A Century of Progress in Plating.

Four of the greatest features ever offered a Convention of the American Electro-Platers Society.

If You Miss It—You'll Regret It

PLATING OF ZINC BASE DIE CASTINGS

By R. J. Wirshing
General Motors Company
Read at Philadelphia Convention, 1932

Zinc, as a metal, is adaptable for use in a number of places, particularly in the automotive industry. Three of the properties which make it attractive to the engineer are:

1. It is low in cost.
2. It has a melting point which makes it particularly adaptable for use in the manufacturing of die castings.
3. The products of corrosion are white and, therefore, much less objectionable in color than the red rust of iron.

As to the cost and use for die castings, no discussion is necessary. The remark regarding the products of corrosion must not be misconstrued as meaning that the automobile industry is content to accept a material which corrodes. On the contrary, we are constantly waging a battle against corrosion, but since we have not been successful in completely eliminating this highly objectionable feature, we feel that the white corrosion products of zinc are to be preferred to red iron rust. This is particularly true under present conditions with the trim of our cars being practically all white metal.

The chief objection to zinc, and the one we feel has retarded the use of this metal, has been the rapid failure of plated zinc parts in service, as well as the difficulty the plater has experienced in plating zinc.

While it is true that plated zinc parts have been used with satisfaction for interior exposure, the especially severe service requirements for automobile trim make it necessary to do a much better plating job than is required for interior use.

Much work has been done in evolving methods of plating on zinc to obtain a finished part that is durable in service, but the recommended methods are contradictory in many cases. For example, after much excellent research work the New Jersey Zinc Company advises plating approximately .0003 of an inch of nickel directly on the zinc and frowns on the practice of plating copper directly on the zinc. On the other hand, in "Electrochemistry" by Brockman, on page 128, we read, "The deposition of nickel on zinc and tin directly is not satisfactory but is excellent after a copper strike."

We have no quarrel with either source of information, but call

attention to them to indicate that in our search for a suitable means of producing satisfactory deposits on zinc we were met with many conflicting statements as to just how the job should be accomplished.

While we are interested in the theories advanced as to why this or that method will or will not be satisfactory, we are more concerned with the ability of the finished pieces to hold their good initial appearance in service. Of course, it is understood that while durability is of prime importance, any complicated method of plating that would greatly increase the cost of production will most surely not be adopted except perhaps in cases of small production of high-priced models.

In the plating of steel parts, three points have come to our attention:

1. Sad experience in the past has taught us that durability of plated metals is a function of the thickness of the metal deposited. In other words, the thicker the deposit, the greater the possibility of having a durable plate. Since this fact has become recognized, specifications covering plated parts, especially steel parts, have gradually increased the thickness of deposits called for until, at the present time, .001 of an inch total deposit is usually demanded.
2. Experience has also taught us one other fact. Most of us in the early days of chromium plating discovered that a thin deposit of nickel would be lifted by a chromium deposit. This same condition holds true to a lesser extent with other metals. By this we mean that we do not think it advisable to plate a heavy deposit of any metal over a thin deposit of a dissimilar metal.
3. We have found through experimentation that better protection against corrosion can be gained by plating two metals of a certain total thickness than by plating one metal of the same thickness. In other words, .001 of an inch of nickel on steel will not afford the same protection as .0005 of an inch of copper and .0005 of an inch of nickel. One theory advanced to explain this fact is that the pores in the first deposit are somewhat covered by the second metal. We are not prepared to offer an explanation.

Since we have proven these three facts to our own satisfaction in regard to plating on steel, we can see no reason why they should

not be applied also to plating on zinc. Summarized, they are as follows:

(*a*) Total deposits should be at least .001 of an inch thick.
(*b*) No thin or "flash" deposits should be used, except the top coat of chromium.
(*c*) At least two dissimilar metals should be plated, exclusive of the chromium "flash."

Following out these recommendations we plated a number of zinc base die castings, using .0005 of an inch of copper and .0005 of an inch of nickel followed by the usual chromium deposit. Pieces plated in this manner gave such a good account of themselves that this method was adopted in production and daily, for almost nine months, thousands of zinc base die castings have been plated in this manner and their record in service has been extremely good.

To outline some of the advantages of this method of plating on zinc; you are all familiar with the difficulties of plating nickel directly on zinc. The pH of the nickel solution must be kept high and within a narrow range (5.8 to 6.2) because of the tendency of the zinc to go into solution causing black streaks on the deposit. Even with precautions the solution usually becomes contaminated with zinc and, according to Anderson and Reinhard of the New Jersey Zinc Company, amounts as small as 0.3 gram per liter (0.04 ounce per gallon) cause streaking. This makes it necessary to purify the solution, an undertaking that is time consuming and by no means simple.

With a solution of this high pH it is necessary to plate slowly, using a current density of 15 to 20 amperes per square foot which

BUREAU OF EDUCATION

"Elementary Course In Chemical Analysis of Plating Solutions"

In order to supply the demand for this important Booklet, the Bureau had an additional 100 copies mimeographed. If you have not placed your order, please do so before the supply runs out. Price $1.00.

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would require about 30 minutes to deposit .0005 of an inch of plate. Also it is usually necessary to agitate the cathode.

By the method of plating we are now using nickel is plated on a deposit of copper. This allows the use of a low pH nickel solution without danger of dissolving zinc. This solution can also be used to plate brass and steel, making it unnecessary to have a special nickel tank for die-cast work. At the same time, much higher current densities can be used with the resultant shorter plating time. For example, at 60 amperes per square foot, .0005 of an inch of nickel can be deposited in 13 minutes.

To deposit .0005 of an inch of copper using 20 amperes per square foot, it requires about 22 minutes. Thus it can be seen we can deposit .0005 of an inch of copper and .0005 of an inch of nickel, a total of .001 of an inch of plate in 35 minutes, which compares very favorably with the 30 minutes required to deposit .0005 of an inch of nickel from the high pH nickel solution.

One other method of plating zinc base die castings that has given good results on tests consists of plating nickel first, followed by copper, nickel and chromium, making the total deposits .001 of an inch thick. This meets the requirements laid down, heavy deposit, dissimilar metals and no flash plates. However, this is a more expensive method than the one we are now using.

The method of plating a heavy coat of copper directly on the casting followed by a heavy coat of nickel, which we believe is also applicable to sheet zinc, is submitted to the members of the Electro-Platers Society, not on the basis of experimental data, but as the result of thousands of pieces plated in regular production, service records on which speak for themselves as shown by a few samples on display here. (Applause.)

CHAIRMAN GRAHAM: Mr. Wirshing's paper is so similar to the one that follows it might benefit both authors to discuss them jointly. So with that in mind, we will proceed with the presentation of the next paper, which is entitled,—

STUDY OF BASE METALS USED IN INDUSTRIAL CHROMIUM PLATING APPLICATIONS

By Lieutenant Arthur Willink
of the United States Arsenal, Frankford, Philadelphia, Pa.
Read at Philadelphia Convention, 1932

The subject of this paper offers a fertile field for a long, scientific dissertation flavored with considerable mathematical discussion.

Today plating is no longer confined to covering metals for decorative and anti-corrosion purposes, but, particularly in the case of chromium plate, electroplating has been put to industrial uses for wear resistance. In these applications the base metal (or metal upon which the chromium is plated) plays an important part in the success or failure of a chromium plating application. The object of this paper, therefore, is to acquaint the electroplater with the factors involved so that a clear picture of what occurs in the use of a chromium plated tool may be formed.

The factors that must be considered can be divided into three classes:

1. The nature of the forces acting on the tool or die
2. The physical properties of the base metal
3. The operating temperature

In the majority of cases it is rather difficult to get an exact quantitative picture of the above named factors, and an intelligent guess as to just what is happening is about all that can be given. With reference to the first factor, the forces acting upon the tool can be divided into two groups:

(*a*) Those acting normal or perpendicular to the surface of the tool

(*b*) Those acting tangentially to the surface of the tool

The normal or perpendicular force is usually the one that must be reckoned with in determining the suitability of a base metal. The tangential force is usually the one of friction, and in the case of chromium plated tools with a comparatively low coefficient of friction this force becomes very much reduced and usually need not be considered. In most cases the forces acting on a tool are neither of the above, but are the geometric sum of forces of the above nature. In other words, the actual force acting can be divided into its normal and tangential components. It must now be considered as to whether the force is in the nature of an impact or whether it is gradually applied. In the case of impact the force is twice that of force gradually applied. The next thing to consider is the area over which the force acts, and by dividing the force by this area it gives the force per unit area and pounds per square inch. Entire units are so proven. It can be seen from this discussion that the force per unit area can be minimized by increasing the area upon which the force acts to the maximum practicable. It is now necessary to find the fibre stress in the base metal. In some

cases, this is very simple, as the fibre stress is uniform and the same as the force per unit area. In other cases, particularly in hollow cylinders which are most frequently encountered, this is not the case and the formulae of Lamé have to be resorted to. These can be found in any standard work on mechanics of materials. In some irregular shapes fibre stresses may be nearly impossible to calculate.

The second factor, that of the physical properties of the base metal, will now be considered. The usual case of failure of chromium plate is due to the fact that the base metal has been deformed beyond the elastic limit, which consequently causes the failure of chromium plate deposited upon it. It is therefore essential that in any tool the base metal be not stressed beyond the elastic limit. In some bases it is impossible to lower the stress to accomplish this and therefore the elastic limit of the material itself has to be raised. This is, of course, influenced by the material itself, but physical treatment, such as heat treatment or cold work, can change the elastic limit over wide limits. As a rule, in using a steel which has been heat treated to give a very high elastic limit brittleness and tendency to crack due to hydrogen embrittlement caused by chromium plating is encountered, and many tools have failed in this way. In some cases, excessive local strains are set up due to grinding. These have likewise caused failures in tools. A method which is coming into favor for draw dies is the method of cold work. Not only is the elastic limit of material greatly increased by cold working, but in the case of a hollow cylinder it is possible to put the interior fibres into an initial state of compression, thereby greatly increasing the allowable unit stress before a permanent deformation takes place. This cold working is done by forcing a mandrel through the die or if the cylinder is long enough and practicable, hydraulic pressure is resorted to. This is similar to the autofrettage used in the manufacture of guns.

The third factor, the operating temperature, is important, as it involves the physical properties of the material itself. Practically all materials show considerably lower elastic limits at elevated temperatures, consequently a tool that will not deform while it is used cold may deform at an elevated temperature. In some cases, the heat generated in the use of the tool causes such deformation due to higher temperatures.

In conclusion, this short paper is intended to give the electroplater a very general idea of what has happened in case a tool that he has plated has failed. In comparatively few cases is the failure of the tool due to the actual plating. It is mostly due to failures in the base metal. (Applause.)

CHAIRMAN LUKENS: I am sure that, could Lieutenant Willink have been present and heard Dr. Graham's reading of this paper, he would be quite gratified, as I know you all must be. Are there any who wish to discuss the paper? Have none of you been confronted with the failure of chromium deposits on dies which are intended to resist wear, and felt inclined to attribute it to the base metal rather than your technique?

MR. GEORGE A. WILSON: I would like to ask Dr. Graham if he thinks it is possible to plate a thread cutting screw die successfully. I will explain that better, possibly, by saying that the recesses in those dies run anywhere from almost nothing to an eighth of an inch deep, corrugated, as it were, and what I am trying to get at, is it possible to throw into the recesses without plating so heavily on the top so that it would ruin the die.

DR. GRAHAM: I think there, it is a problem of how satisfactorily you can throw chromium into a recess on that particular object, and while that is not necessarily discussed in this paper, I think there are plenty of people here from the Chromium Corporation who would probably rather discuss how capable they are of throwing chromium into a die of that type. Not that I am trying to pass the buck, but I would like to hear from them on the subject.

CHAIRMAN LUKENS: May we be favored with such comments?

MR. WILSON: I don't see anybody making any explanations on the matter, so I will say I have tried it several times, and I wonder if it would make any difference if that metal was treated or not treated; that is, if it was hardened or not hardened before plating.

DR. GRAHAM: I would say as far as the ease of deposition of chromium on any base metal, that heat treatment would not affect it, provided you ultimately prepare your surface so that it is active, ready to plate. Now, if you are going to have an alloy steel in your die, or a die of high chromium content, the degree to which you would have to go in preparing that surface to make it chemically clean and active prior to chromium plating might differ from that of an ordinary steel or copper surface. But it is largely a matter of how you prepare that surface what success you might

have in addition to the physical shape of the thing itself. The throwing power would therefore depend upon the physical shape, how deep you have to throw, and how well you have prepared your surface, whether the metal will take.

MR. W. H. PHILLIPS: I would like to horn in on this. I never have plated the particular thing Mr. Wilson mentions, but we have plated thread gauges and we have plated reamers, and also taps. In doing that, we plate more on the high spots than the low spots, and grind it down afterwards to the proper dimensions. Would that be objectionable?

MR. WILSON: We cut the die to the exact dimensions.

MR. PHILLIPS: It would be a little harder to calculate, because you would get a rather uneven distribution. Perhaps it would be better to regrind. But it has been done that way—putting the chromium plating on, and regrinding to the proper size afterward.

DR. GRAHAM: May I make one more comment? Mr. Hogaboom mentioned something to me which might possibly assist us, and I will take the liberty of repeating it to you. Simply this—that in interpreting Mr. Wilson's remarks, if you have a thread on a die which is used to roll in a thread, if it is that type of operation, and you are interested in depositing chromium on it uniformly, it is a problem of throwing power, as I interpreted your question in the first place. If, however, it is a question of the manner in which these sharp edges of the thread are retained in that operation, it may be a matter of the ability of the base metal to retain its shape with a sharp edge there on each of the threads. In other words, if there is considerable force in the operation, there is very little metal at that tip with a sharp edge and it may be deformed. In other words, if the force is such that you are beyond your elastic limit, the metal itself will flow under the chromium and lose its sharp edge, and the whole thing fail because of that.

MR. PHILLIPS: I have one more remark to make on this which very nicely demonstrates that deformation. We had two parts of a die. One was a plunger, and the other was a ring. The plunger did not deform, whereas the ring would scratch every time a stamping was made. We could plate the plunger satisfactorily, but not the ring.

MR. GEORGE A. HOGABOOM: Some work was done on that in drawing that was very interesting. A die similar to what Dr. Graham or Lt. Willink mentioned in the paper. A die with a wall

that slants so there won't be that abrupt breaking down in the drawing.

In finding out why chromium failed upon such a die, it was noted that it deformed here. (See "A" in drawing.) And they took a die that had not been chromium plated and weighed it very carefully, and then ran it until it was oversize and found that it had lost practically no weight, but what had actually happened was that this metal had flowed, and it just blowed at the outside edge, and it deformed. Now, to prevent that, the amount of chromium that would have to be deposited upon that surface would have to be sufficient so as not to allow the base metal to flow under it, or else it would peel. That is dependent upon the metal that is drawn through that die. Copper is a soft metal and it doesn't require such a heavy plate. But if you were drawing nickel, or monel metal, you probably would have to go up to ten to fifteen thousandths of an inch of chromium on those dies so as to prevent the deformation of the steel. And it is the same thing on your rolled thread dies. One of the greatest difficulties in rolled thread dies is to get a uniform hardness on that peaked edge. You will find that they will break at different parts. In doing some work on that, we silver-plated them and then salt hardened them, and in that way got a uniform hardness throughout, and it wasn't due to the electrodeposit that that failed, but due to the lack of uniformity of hardness throughout the die, that some parts were glass hard, while other parts weren't so hard, and where it was glass hard, it just broke.

MR. WILSON: I might say in connection with that, that the dies were a failure, and also, the throwing into the threads of the screws, the slots, plating there, it was the same thing.

MR. J. ROLFF: I would like to ask Dr. Graham a question in relation to the base metal of the die in question. Now, for instance, say, I plated some drawing dies. It was really a hollow punch. That is, it stamped out the base metal, then the punch came down and drew it up. They asked me to plate the inside of that die, just the inside shoulder, where that wear came, and it was principally

friction. The previous experience with this punch was, they would run about 200,000 pieces and then they would have to take out the die and lap it; it would become scratched from the hard particles on the sheet steel. I did merely a haphazard chromium plating job. By that I mean I just rigged up a home-made jig and put a little pencil anode in there and deposited chromium on the inside and gave it back to them, and repeated tests showed that we ran from the 200,000 maximum till we got up over 1,000,000 and then they came to the place where, instead of the chromium surface wearing off, or having any scratching of the product, the die broke. And the question I would like to ask is this: If that die, for instance, had been hardened and tempered to a certain tensile strength, and we plate it with chromium, in a chromium solution—bearing in mind there was a vigorous evolution of hydrogen—is there any possibility that there might be an inclusion of hydrogen in the steel, changing the physical characteristics of the steel?

DR. GRAHAM: If you chromium plated just the inside surface, and the rest of the steel die was exposed to your solution it is entirely possible that hydrogen embrittlement could occur. I don't know how long that effect would continue after you took it out of the plating operation and put it in surface, and ordinarily if you are doing anything like that with steel, it is best to attempt to remove the embrittlement before you use it under any conditions.

MR. ROLFF: By heat?

DR. GRAHAM: Yes.

MR. MUIR: My experience on that type of die has been that chromium has generally been a failure. It chips and comes off. In punching out condenser blanks, the thing flakes off after a few operations, so I don't think it is successful at all in that type of die.

DR. GRAHAM: In reply to that, I must say I merely used a rough diagram to illustrate the principle I was discussing. Lt. Willink has had experience, I know, with a great variety of dies and I am sorry that he was not here to discuss more intimately the type of dies that he has had experience with. I would suggest if you have had difficulty, you communicate with him.

MR. MUIR: I happen to have the same type of die he has, punching out the same shaped work, but it doesn't stand up.

CHAIRMAN LUKENS: Is there any representative of the Mint present? My understanding is that they have had considerable

experience on the effect of chromium plating on dies used for coinage.

DR. BLUM: Perhaps I can state briefly, although Mr. Blyth is not here, that on the actual coinage dies they find they get better results with a thin coating of chromium than with a thick coating because, as the last speaker said, a thick coating is likely to flake. On the other hand, where they have a ring which serves simply as a form to hold the coin in place while it is stamped, the life of that ring has been increased as much as tenfold by chromium plating inside of it, which prevents scratches. I think it is more a question of resistance to abrasion than to impact. So they have found some cases where it doesn't work, but other cases where it works very well.

THE LIFE OF PLATED ZINC AS AFFECTED BY THE THICKNESS OF THE COATING

By E. A. Anderson
Research Division, New Jersey Zinc Co.
Read at Philadelphia Convention, 1932

A. Introduction.

A good chromium plating job admittedly is an attractive sight. The very attractiveness of the finish has, however, produced a serious problem in the plating industry. It marks another raising of standards of appearance by which an increasing critical consuming public is judging plating. The modern buyer takes such pride in the beauty, design and finish of his purchase that he has automatically raised his mental conception of how long this appearance should last. It must be admitted that a great deal of the plating produced today is more attractive than durable. Failure to recognize the growing demand for more durable plated finishes must eventually result in increasing competition with other types of finish.

Zinc has suffered from inferior plating protection in the same way as the other common metals. The difficulty seems to lie in the extreme thinness of the plated coatings usually applied and can only be remedied by a definite increase in the thickness of the coating.

Realization of the necessity for thicker coatings brings with it the problems of selecting the minimum thickness for satisfactory outdoor service and the development of methods of test to confirm the presence of this thickness. The present paper offers the data on these points accumulated by the writer and his associates dur-

ing the past three years and is presented in the hope that the information given will be of some help to the plater who desires such information.

It may be pointed out that the discussion is limited to nickel-chromium coatings for outdoor use. It should not be inferred that only such coatings will be satisfactory. Although the writer favors the simple nickel-chromium coating, it is freely admitted that any coating which is shown to be of equal cost and equal protective value is just as acceptable.

B. Tests to Determine Service Life.

Before proceeding with any discussion of the relation of thickness of coating to rate of corrosion, it would be well to convey some impression of the service life obtainable from a given coating.

No matter what type of test is used for comparing the corrosion resistances of a series of plated coatings the fact remains that the results are meaningless until it is known how long they stand up in commercial service. All that any test can do is to tell us that coating A is better than coating B. Only actual service tests can tell us whether the added expense of coating A is necessary. It has been our practice to install plated zinc parts on private cars in Palmerton, Pennsylvania, in order to obtain just this type of information. The longest test carried out thus far is on a set of plated rolled zinc running board mouldings installed February 11, 1930, on a Buick car operated by the New Jersey Zinc Company. At the present time this car has been run some thirty-two thousand miles in the two and one-third years which have elapsed. The plated coating applied was a nickel-chromium deposit of about 0.0003″ in thickness. At this writing, March 15, 1932, the moulding still shows to be free of any corrosion.

A similar exposure test was made on a private car operated in the east central part of the United States. A report from the owner states that after eighteen months of use, in which the car stood outdoors for twenty-four hours a day, the mouldings showed no corrosion. The total mileage was 14,231 miles in this period. The plated coating in this case was also 0.003″ of nickel and 0.00002″ of chromium.

Shorter time test data are available on plated zinc hub caps. In this case two caps were finished with 0.0001″ of nickel and 0.00002″ of chromium and two with the 0.0003″ of nickel and

0.00002″ of chromium. After nine months of exposure on the same car, the thinner coating has started to fail. The 0.0003″ coatings are still in perfect condition.

It is apparent that the weight of our evidence points to the inferiority of thin coatings and further that the 0.0003″ coating has given good service for at least two years. It is realized that the exposure tests have been confined to the northern part of the United States. On the other hand, some continuous exposure data are available which indicate that the rate of corrosion at Palmerton, Pennsylvania, is more rapid than at certain southern exposures.

C. Continuous Exposure Tests.

In the investigation of the outdoor corrosion resistance of plated coatings the writer prefers to use the continuous outdoor exposure as a test. This is in a sense an accelerated test, since comparative tests have shown that it will produce failures in a fraction of the time required under even severe service conditions. The fact that continuous exposure tests include exposure to the early morning dews and do not include the frequent renewal of the grease film which ordinarily occurs in service, as for example in the washing or polishing of a car, probably accounts for this marked difference in life.

The salt spray test is not sufficiently reproducible for investigative work and to our minds has no place in researches on the durability of plated coatings.

In the search for other substitutes for the continuous outdoor tests some little time has been spent on the development of porosity tests of plated coatings on zinc since porosity is the fundamental cause of failure. The results so far have been discouraging. As illustration, a series of plated specimens were cut into two parts; one set of which was exposed outdoors. The other halves were tested for porosity by immersing them in a hot 10% solution of sodium hydroxide. The evolution of hydrogen when the caustic soda attacked the zinc under the coating gave an excellent visual impression of the number and size of the pores. Unfortunately, however, the number and distribution of the ultimate corrosion blisters obtained on the specimens exposed outdoors were far from being in agreement with the results of the porosity tests.

The suggested explanation of this failure of the porosity test to agree with the exposure test is that the porosity test located

only the larger pores, while the longer and slower exposure test permitted even the finest pores to be penetrated.

The continuous outdoor exposure test offers the outstanding advantage of using only natural means of accelerating corrosion. The results when correlated with service tests, such as the running board moulding tests previously described, furnish valuable data on the life to be expected from any coating. It must be emphasized, however, that the correlation with service conditions must be made if the data are to have any meaning.

D. The Mechanism of Corrosion of Plated Zinc.

A brief discussion of the mechanism of corrosion of plated zinc will help in the appreciation of the necessity for thicker coatings. In reading this discussion it should be borne in mind that the general theorems involved are equally applicable to other metals.

Zinc in contact with water at room temperature corrodes to form the hydroxide. Under normal conditions of drying, carbon dioxide in the atmosphere reacts with this hydroxide to form a relatively insoluble oxy-carbonate film which greatly retards the further progress of attack when water is again applied. This mechanism explains the exceptional life obtained from rolled zinc in the outdoor atmosphere.

Under certain conditions the normal protection afforded zinc by the oxy-carbonate film is not realized. For instance, zinc held continuously in contact with stagnant water will corrode more rapidly than normally and during this corrosion will form a bulky white zinc oxide corrosion product. In explanation of this type of attack, Ulich Evans has demonstrated that variations in the oxygen content of the water in contact with zinc are of great importance.

When areas rich in oxygen and poor in oxygen exist in the same film an electrochemical cell is set up in which the metal in contact with the latter areas is subjected to an acceleration of the normal corrosion. Such a condition can arise as the oxygen near the metal surface is used up in the side reaction with the atomic hydrogen set free during the corrosion cycle.

When drying can occur in a relatively short time, say fifteen minutes, none of these reactions can proceed very far. On the other hand, if the specimens are kept wet for three or four hours, uneven oxygen concentration will probably occur in the water film and furnish a potential source of rapid corrosion.

The application of these theories to the corrosion of zinc under a plated coating is not difficult. All plated films contain discontinuities, commonly termed "pores." These pores permit access of rain water and dew to the underlying metal. Each pore then becomes a small corrosion cell.

Atmospheric moisture normally contains enough sulphur dioxide and carbon dioxide to be a fair electrolyte. In contact with two dissimilar metals, such as nickel and zinc, an electrochemical cell is set up in which the zinc corrodes to protect the nickel. Such a condition may be observed in nickel plated zinc.

The moisture in a pore may be visualized as a column of water, one end of which is in contact with the base metal and is depleted in oxygen content by the corrosion side reaction. The other end is exposed to the atmosphere and can reach equilibrium in oxygen concentration. The reactions postulated by Evans can proceed actively under these conditions.

The two effects discussed above are additive and can, under adverse moisture conditions, result in moderately rapid corrosion of the base metal at the bottom of a pore or pit. The corrosion product formed in the case of zinc is the bulky zinc oxide. Iron corrodes in similar fashion to form characteristic tubercles of rust. In both cases the corrosion product demands more room than is available in the bottom of the pore and pushes up the coating in the form of a corrosion blister.

Since corrosion of plated metals can take place only in pores, the logical solution of the problem is to eliminate the pores. Unfortunately plating methods have not yet advanced to the point where perfectly continuous films are obtained. The only other path open is to increase the thickness of the films to take advantage of an apparent tendency for the number and size of the pores to decrease as the coating becomes thicker. As the coating is increased the depth to which moisture must penetrate before active corrosion starts also increases. Since the natural surface tension of water will tend to increase the difficulty of making such penetration, it is logical to believe that in the heavier films the moisture may often dry out before the base metal is reached.

E. The Relation of Thickness of Coating to Outdoor Corrosion Resistance.

In order to demonstrate the effect of thickness of a coating on the life of nickel-chromium deposits on zinc, a series of specimens were prepared as follows:

1. 0.00005″ Ni + 0.00002″ Cr
2. 0.0001″ Ni + 0.00002″ Cr
3. 0.00015″ Ni + 0.00002″ Cr
4. 0.0002″ Ni + 0.00002″ Cr
5. 0.0003″ Ni + 0.00002″ Cr
6. 0.0005″ Ni + 0.00002″ Cr

In each case the coatings were applied to rolled zinc stampings by the methods described elsewhere by the writer.* The specimens, prepared in duplicate, were exposed outdoors for one month, at the end of which time the low power photomicrographs shown on Figures 3 to 8, inclusive, were taken. These photographs need little discussion. The consistent improvement in appearance with increased coating thickness is apparent. It was noted above that, under actual service condition, the 0.0001″ coating failed after nine months of service. The 0.0003″ coating gave two years and three months of service before failure became apparent.

F. Methods of Measuring Thickness.

Any discussion of thickness brings with it the question of methods of measurement. There are several methods available, some of which are discussed below. Possibly other methods with which the writer is not familiar are in use.

With a solution of known efficiency the plater can, of course, regulate his thickness of coating by varying the time of deposition. A more accurate method is that of measuring the increase in weight during the plating operation of a cathode of known area.

The purchaser of die castings must rely on direct measurement of the coating thickness. Three methods for the purpose are available, each of which offers advantages in specific cases.

Direct measurement at specific places can be made by stripping the nickel from the zinc in a suitable stripping solution and measuring the coating with a special micrometer equipped with a vernier. Brown and Sharpe No. 24 and Slocomb No. 25 or No. 26 —0 to 1 inch range, graduated to ten-thousandths of an inch, are typical. We would emphasize the necessity for special measuring equipment, as the ordinary micrometer is not sufficiently sensitive for the purpose. In most cases it will be found advantageous to protect the nickel with a gummed paper label or other expedient to prevent disintegration by the hydrogen evolved in stripping.

*E. A. Anderson, "The Present Status of Plating on Zinc"—Metal Cleaning and Finishing—Vol. 3, February, 1931.

A second method of direct measurement at selected points involves the use of a good microscope. A suitable section of the sample is mounted and polished as a micro-section. Examination at 1000 to 2000 diameters permits accurate measurements of coating thickness to be made. It is possible also to identify the type of coating and to study the distribution obtained at selected corners and recesses.

Both of the methods discussed have the disadvantage of being restricted to small areas of the coating. To obtain the entire picture of distribution and particularly to obtain an accurate estimate of the average thickness requires considerable work. For this purpose a third method is available.

If a specimen of known area is dissolved in hydrochloric acid an estimation of the total weight of nickel can be made quite readily by the dimethyl glyoxime method. Using a value of 8.8 for the specific gravity of electrodeposited nickel, the average thickness may be calculated by the formula:

$$\text{Thickness (inches)} = \frac{\text{Weight of nickel (grams)}}{143 \times \text{area (square inches)}}$$

The stripping-chemical analysis method depends for its accuracy on the accuracy of the measurement of the surface area of the sample. Simple shapes are, of course, readily measured, but there is need for an accurate method suitable for more complex shapes.

G. Present Commercial Coatings.

It is interesting, in the light of the above discussion, to consider the present status of weights of coating on zinc. In the past year we have made 59 weight of coating determinations on commercially plated rolled zinc and zinc die castings. The results are assembled in Table I.

TABLE I

Thickness of Coating in Inches on Commercially Plated Zinc

Thickness Range	*Number*	*Per Cent of Total*
Less than 0.00010″	20	34
0.00011 to 0.00015″	14	24
0.00016 to 0.00020″	7	12
0.00021 to 0.00025″	5	8
0.00026 to 0.00029″	6	10
0.00030 and over	7	12

Only 12 per cent of the coatings measured were of suitable thickness for acceptable service, while 34 per cent of the measurements ran under 0.0001". While this compilation cannot be accepted as a final representation of all commercial plating on zinc, the samples were obtained at random from a variety of sources. It should be apparent that the present commercial practice leaves much to be desired. (Applause.)

There is just one point about Mr. Wirshing's discussion that I would like to comment on at this time, as I think it is rather important in appreciating what we have here to say. Mr. Wirshing pointed out that nickel deposits plated in a high pH bath require something around thirty minutes to deposit 0.0005". That is true of a two-ounce nickel solution. A three-ounce nickel solution, however, is now available which permits current densities (and this is being done commercially at the present time, has been done for over a year) as high as 37 amperes per square foot, which makes the rate of deposition rather a different story. I am not at all sure that that relatively high speed that is obtainable is known as generally as the normal two-ounce solution with its 15 to 20 amperes per square foot.

CHAIRMAN GRAHAM: Now, we have just had, I think it is the consensus of opinion, two very interesting papers. There are undoubtedly a number in the audience who would like to make some comment or ask some question, and I am sure that both these gentlemen will be glad to answer them.

MR. P. W. C. STRAUSSER: Mr. Wirshing made the statement that in using copper plating, you use the usual pH solution. Now, what is meant by the "usual"?

MR. WIRSHING: Well, throughout the General Motors Corporation—not in all of our plants, but the majority of them—we are using a nickel solution with a pH of about 2.

MR. STRAUSSER: I think we can differentiate somewhat between these two papers, Mr. Chairman. From the remarks made by Mr. Anderson, I believe the study was made on strip zinc, whereas in the case of Mr. Wirshing, it is on zinc die castings, which is a 4-3 alloy. In this particular case, we have more of a tendency to get into a blistering condition and a corrosion condition, whereas in strip zinc we are not apt to get into that state of affairs. Now, has not most of the work been conducted on strip zinc, Mr. Anderson?

MR. ANDERSON: The work which I reported here has been. As I say, our tests on die castings have not progressed far enough to give us the story that we have on rolled zinc. We started our first exposure work on rolled zinc. I will say this, that, on continuous outdoor exposure tests, the failure on a given thickness of coating in our tests occurs about the same time, the same duration of exposure, on die castings as it does on rolled zinc. Whether that will carry out on the service tests, we can't say. We will simply have to wait for the service tests to bring out the records.

But I will say one thing. Mr. Strausser mentions die castings being a 4-3 alloy, the intercrystalline oxidation could accelerate blistering of the coating. That was true of alloys in the not distant past. The modern zinc base die casting, however, prepared with 99.99% pure zinc, practically is free from intergranular attack as much as any commercial material. In other words, corrosion has a slight tendency in practically all materials to try to be intergranular. In some cases it succeeds, but we have little if more corrosion of that type in our die castings today than you have in any other material.

MR. STRAUSSER: Another point. I believe the salt spray was mentioned as not satisfactory as an accelerated outdoor test. I wonder whether Mr. Anderson could offer some solution as to what accelerated laboratory test we can use to give us quick results? Of course, we can't wait twelve months to give the inspector some idea of what we are getting. For instance, the industrial test is SO_2 plus CO_2 and air.

MR. ANDERSON: I believe you misunderstood what I said, Mr. Strausser. What I meant to imply was that the salt spray test isn't sufficiently sensitive for investigative work, where you are investigating a series of plated coatings or a series of types of plated coatings. For industrial work, we have no quarrel with it, if the user is satisfied that it is reproducible. We have no test to replace it. The field of development of accelerated tests is one in which we have stumbled and bruised ourselves so badly we hesitate to say any more about it. We developed the CO_2 SO_2 accelerated weathering test and now we are among its bitterest enemies.

MR. WIRSHING: Mr. Chairman, I might say, in regard to testing plated parts other than zinc parts, if you are plating on steel, for example, we get very quick results in our Florida exposure field. The plating of nickel and chromium, copper, nickel and chromium

on steel—we send the parts to Florida, and the failure will occur within thirty days. If the piece is going to fail, you will find practically all of your spots of failure within thirty days. After that time, there is a gradual, very gradual increase or spreading of these spots. But we have taken the stand now on steel parts that if they will stand up for thirty days in the Florida test field, they will be pretty satisfactory, although we cannot correlate the results of the salt spray with outdoor exposure in any way.

DR. WILLIAM BLUM: I would like to suggest that Mr. Wirshing tell us about the methods of copper plating that he used. That would help in the further discussion.

MR. WIRSHING: At the plant where they are doing most of this work, they are using a cyanide copper solution for the entire deposit. In some cases the copper is buffed, and if they are not so particular about the appearance they don't buff the copper, they simply buff the nickel after it is put on.

MR. BOOTH: Another question—is the base metal matted, the same as in applying a direct nickel, with the copper cyanide bath?

MR. WIRSHING: It is given an acid dip.

MR. BOOTH: The reason I ask that, Mr. Fox, of the Dohler Die, came down to me when I first started down there, and I started off with the cyanide copper, more as a flash plate than as a thickness plating, and he took several of my pieces and sent them to Toledo, to the Dohler Die people there, and they gave it a steam test, a 24-hour steam test, and when they came back, of course, it was all stripped and the copper was exposed and the zinc was all white spotted. And he condemned the use of copper on a die casting. I told him the reason for it is the copper has a tendency to turn the zinc, causing an air surface in between there.

MR. WIRSHING: We also condemn the use of flash copper, but we feel if you are putting on a half a thousandth of copper, you are really getting a tube of copper surrounding the article that you are plating.

MR. ANDERSON: I would like to add one thing to Mr. Wirshing's answer to your question. Mr. Wirshing quoted us as saying that we did not like a flash of copper next to the zinc. That is quite true, we don't. A thick coat of copper is an entirely different thing. A flash coat of copper will absorb into the zinc, dissolve into the zinc, too rapidly to be of any use to you and may damage the adhesion. A thick coating of copper, half a thousandth, is an

entirely different story. It takes too long to absorb that to worry about it.

DR. WILLIAM BLUM: If I may comment now on those results, I think just in line with what Mr. Anderson has said, making a parallel or drawing a parallel with the results as far as they have gone on the exposure tests on steel which we are going to report on, briefly, on Thursday—we can anticipate by saying that for thin coatings which are decidedly porous, the copper seems to be a disadvantage, that is to say in the case of the steel at least, to accelerate the rate of corrosion of the steel, and presumably it would accelerate the corrosion of the zinc. So that in both cases, on steel and on zinc, it looks as if the copper, if it is put on there, must be or constitute a part of a coating that is sufficiently thick to be practically impervious, and if it is, then if the moisture can't get through it doesn't make any difference whether copper is there or not, because the copper can't accelerate the corrosion. So, as it looks to me, it is simply a question of which procedure is going to give you the most nearly impervious coating of a given thickness. At least, we would draw that conclusion from the steel, and I think it would probably apply to the zinc.

MR. WIRSHING: I think Dr. Blum is correct. We have had zinc base die castings on exposure on which a thousandth of an inch of nickel was plated and they stood up very well. However, as we called attention in the paper, it is difficult to plate a thousandth of an inch of nickel directly on zinc, much more difficult than to plate a half a thousandth of copper and half a thousandth of nickel.

MR. G. B. HOGABOOM: Mr. Wirshing said that a regular nickel solution, such as is used for brass, could also be used if the zinc was heavily copper plated. This is probably true of round or flat objects. But suppose it should be recessed work in which the copper did not protect the inside. Would there not be a tendency for the attack of the zinc, and the zinc go into solution in such cases?

MR. WIRSHING: We have had no difficulty along that line with any type of piece we have been called upon to plate.

MR. HOGABOOM: Would you expect it?

MR. WIRSHING: No.

DR. BLUM: Isn't the throwing power in cyanide copper likely to be as good as in nickel?

MR. HOGABOOM: But for example, in a screw hole, threads and parts deeply recessed, because some die castings are quite complicated—that it wouldn't be possible to plate all the way down so as to get sufficient copper on there to give you the protection to prevent the attack by the nickel solution. And if a solution was used in which there was nothing like sodium sulphate or sodium citrate to retard the attack of the acid, and if the regular nickel solution was used, such as is used for brass, and steel was plated in the same solution, wouldn't there be a danger in recommending that generally?

MR. F. F. OPLINGER: I happen to know that there are several firms who use a heavy coating of brass prior to the nickel, in place of copper. Just the exact thickness, I don't know, except they plate for probably three-quarters of an hour to one hour, and it would be interesting to know whether anyone has any information showing whether brass is better than copper or vice versa.

MR. WIRSHING: We have plated a few samples on which we put brass instead of copper and, while there weren't enough of them to draw definite conclusions, those few samples plated with brass did not stand up as well as the ones plated with copper.

MR. W. H. PHILLIPS: I would like to make a remark on that. As a general principle, it is rather easier to put nickel over copper successfully than it is over brass. If I had the choice of one or the other, I would take the copper.

MR. JACOB HAY: Since we all agree that, no matter which way we look at it, it has been proved here that it is a failure, then shouldn't we decide along the line that it is up to us to change the composition of the zinc in itself, or else find a method whereby we can change the composition of the solution? Now we all know there isn't a nickel solution in existence today that will give us a deposit that is not porous. The fact has been mentioned that it is almost impossible to get one thousandth of nickel on a zinc casting, although it has been proven and I know there is a solution in existence whereby you can use 300 amperes per square foot and deposit any thickness you desire direct on zinc, although the formula is a secret one and I am not at liberty to give it to you.

MR. CHARLES H. PROCTOR: I think I have had quite a few years of experience in plating industrially. I have experimented a good deal with brass on die castings, but I agree with Mr. Wirshing

that brass is not a successful base coat unless you have a very high copper. But copper, in my estimation, is the best coating to put on a zinc die casting, it doesn't make any difference what you put on afterwards. And so far as the absorption of the copper by the zinc, I would like to know how they are going to determine it is absorbed; when the nickel and chrome are put on top of the copper, how are they going to get the chrome and nickel away without disturbing the copper?

MR. ANDERSON: That can be done very simply under a microscope.

MR. PROCTOR: I am talking about practice, not microscopes.

MR. O. E. SERVIS: I wonder if anyone has ever attempted or experimented with tin coating before nickeling? In other words, tin plating a die casting before nickeling it.

MR. WIRSHING: Yes, we have plated tin over the copper, and directly on the zinc base die castings, but in all cases the results have been unsatisfactory.

MR. W. H. PHILLIPS: I would just like to dwell on a thing that has been mentioned before, and that is the difference between die castings and sheet products. We have holes in die castings we don't have in sheet products, and I think if any leeway is going to be given in the specifications, it should be given to the sheet products.

CHAIRMAN GRAHAM: Unless there is some further comment, I would suggest that we extend a vote of thanks to these two gentlemen for bringing these very interesting papers to us, and I will be very glad to hear a motion to that effect.

(On motion of Mr. Hanlon, a rising vote was extended.)

RECENT DEVELOPMENTS IN METAL LACQUERS

By Kenneth R. Longnecker
of the Zapon Company, Philadelphia
Read at Philadelphia Convention, 1932

The electroplater might be called the inspiration of the lacquer industry, for it was he who was among the first to use lacquers and it is he who still uses a large percentage of the lacquers produced in this ever-growing industry. The plater learned the use of lacquer even before the invention of the now common spray equipment; and even with this new method of application, the arts of dipping, brushing and whizzing are still used, and the man who produces them is still an artisan. You are to be especially

complimented on the beautiful examples of hand dip and hand brush work that are being produced.

Knowing of the sincere interest taken by every electroplater in the lacquer problems encountered in the finishing room, it is the object of this paper to discuss some of the recent trends in lacquer formulation, and more particularly the trend of your field—the formulation of metal lacquers.

Briefly, among the developments of interest to finishers of plated articles should be:

1. The pearl finish and imitation plated finish
2. Synthetic resins and their use in enamels and clear lacquers
3. Decorating and details in plating operations, of chromium
4. The "non-spotting" or, more correctly, the "spotting-out retarding" lacquers

The pearl finish and imitated electroplated finish both use as their base concentrated pearl essence, or, as it is more commonly called, "fish scale." This essence is identical with that used in the manufacture of imitation pearl beads and gives either a mother of pearl or metallic effect. Strange to say, it is not ground fish scales, as is commonly believed, but rather is made from guanin. Guanin is small crystalloid formations emanating from the internal organs of the fish, but lying around and covering the fish scales. One barrel of herring weighing two hundred and fifty pounds produces five pounds of fish scale and one hundred pounds of scale produce but one pound of pearl essence. This accounts for the high prices usually charged for pearl essence.

Since the beauty of this finish is formed by light reflections, and each piece of guanin is flat and leaflike in form, it is necessary to use with pearl essence a lacquer that dries quite slowly. This allows the particles to lie flat or "leaf" properly and gives the proper pearl effect.

In producing the pearl effect now commonly seen in automobile finishes and other novelty work, it is applied in the finishing coats after suitable primers and sand surfacers have been applied. From three to six coats of the pearl lacquer are then sprayed on. This lacquer is formulated from about 6 ounces of concentrated pearl essence, 20% pigmented automobile enamel, and 80% of a weather-resisting clear lacquer, per gallon. This formula may be varied. After the last coat is applied and dried, the body is thoroughly polished. The choice of pigment used is important,

since dense or muddy colors do not give the proper depth of finish. Cobalt and Prussian blues and lake colors in maroons, purples and reds are most suitable.

The imitated plated finishes are usually obtained by the use of dyes to give a metallic effect. A pigmented or dye base background is applied and then a pearl lacquer containing pearl essence, clear lacquer and various proportions of dyes is sprayed on, either one or two coats. A top coat can then be applied if desired. Buffing is also used when desired. It will be of interest to you as platers, who may feel that this latter finish may some day encroach upon your trade, to know that the quite high cost of ingredients, the characteristic fading of dyes, and the delicacy of application will all tend to retard the growth of this finish.

In the manufacture of nitrocellulose hardware lacquer, the three groups of products usually used are solvents and diluents, nitrocellulose and gums. For years these manufacturers depended upon natural gums for their formulating, these being mostly obtained in Africa and the Orient from the fossilized resins of trees and shrubs. Because none of these resins had a steady source of supply with the exception of rosin, and because none of them met all the requirements of the expanding lacquer fields—the production of new or synthetic resins by chemical processes has developed. All of you have heard the term, "synthetic resin," used frequently in your trade papers and in conversation with paint and lacquer manufacturers. The first of these to appear on the market in the year 1893 was the now common ester gum. This is produced as the result of the chemical condensation of rosin and glycerine. If we substitute, in the place of rosin in the latter reaction, organic acids such as maleic and succinic and treat them with glycerine, the alkyd or glyptal resins are formed. Many variations in the organic acids used lead to widely different types of glyptals being obtained.

Everyone here has heard of the bakelite type resins. These are formed from phenol or, as it is better known, carbolic acid and formaldehyde. This type is little used in nitrocellulose lacquers, but modifications of this type are used and are known as "Amberols," "Paraplex" and "Beckasite."

From acetylene and petroleum distillation products we obtain the Vinyl Resins. These are in the experimental stage of development but great claims of resisting corrosion are reported for them.

From the by-product coke ovens we obtain by polymerization of the distilled oils, the paracoumarone and paraindine resins.

The last common group of synthetic resins is obtained from benzol and chlorine and are known as chlorinated diphenyls or the trade name, "Arochlors."

Having briefly sketched the methods of manufacture, let us proceed to the more interesting uses. The greatest of these is, of course, their use in nitrocellulose lacquers. Our laboratory has recently completed testing a series of 150 panels, using all of the common natural and synthetic resins in a series of hardware lacquers. These panels were all brass escutcheons, approximately two inches by six, and were exposed for five months to the weather. When the test was completed, it was found that synthetic resins had surpassed the natural gums in every respect, they having better adhesion, less discoloration, being more impervious to the elements and handling better in the spray gun.

It was found that the synthetic resins dry more slowly and obtain their greatest adhesion to metal more slowly than natural resins. It takes 36 hours in some instances to obtain maximum adhesion.

Some of these resins are very flexible and hold their flexibility for long periods of time. They are known as "plastic resins" and are characterized by the Rezyl Balsams and Paraplex.

Concerning outdoor exposure tests, let me insert a bit of information that will be helpful. Recently, a well-known manufacturer ran a group of outdoor exposure tests of hardware lacquers on solid brass plates about six inches square. The finishing department, in making up these test plates, believed they were doing a favor to the usual supplier of their hardware lacquers by applying an extra heavy coat of that manufacturer's lacquer. This lacquer, although known to be satisfactory for these requirements, broke down more quickly than the other specimens in the test, the reason being too thick a film. Let me warn against the use of any but thin films for atmospheric exposure. The cause of this increased deterioration is additional absorption of ultra-violet rays in the sunlight which cause a more rapid breakdown of the film when refracted through a thicker film.

A large and growing use for synthetic resins is in synthetic enamels. These are composed almost entirely of various resins, pigments and solvents, with the addition, when necessary, of driers and other chemicals in small quantities.

The baking synthetic enamel came first and now the air-drying product is a reality. For the ideal enamel finish on metal at a low cost, the synthetic enamel should meet the requirements, since gloss, adhesion and covering power are all rated highly. This finish, while still in the experimental stage, bears watching and use by the finishing foreman as many improvements have been made in the last few months and more will surely follow, one of the outstanding recent developments being increased resistance to moisture and soap and water. Some resins will stand 48 hours' immersion in cold water without appreciable softening or spotting.

Referring to my third recent development—stop-off enamels and enamels for use on plating racks have been developed and are used to a great extent. These are suitable not only for silver and brass plating, but also chromium work. Racks dipped or sprayed will stand up for long periods of use, while the "stop-off" enamels are for use only during the plating operation.

The decorating of chrome-plated hub caps, humidors, vanities, etc., proved a stumbling spot for the finisher for some time, due, of course, to the greaselike film on the deposit. Clear air-drying primers can now be used that successfully act as a bond coat between the chrome-plate and lacquer-enamels. This procedure simplifies many production schedules.

It is with hesitation that I approach the last section of this paper, namely, "non-spotting" lacquers, because I know that you gentlemen have had more practical experience with these than the chemist or technician. However, let us approach it from a sane and common-sense angle. First, let us acknowledge that there are two types of spotting—(1) "spotting in" or "crystal spotting," and (2) "spotting out" or "stain spotting." Chemists and others engaged in several industries have worked for a number of years to stop these annoying scars from disfiguring the art of the electroplater. Probably thousands of tests have been run, and I am glad to report that progress is being made. No lacquer has yet been made, to my knowledge, that eliminates spotting, but there are several good lacquers on the market that retard the growth of these annoying spots. After a number of years of work, it has been discovered that a good adhesive and impervious hardware lacquer, plus the addition of other chemicals, seems to have a retarding effect on the sulphides or slag from the plating solution and so retard the process of the spotting reaction. This leads one

to believe that the thickness of film of such a lacquer would be inversely related to the speed of the spotting reaction. This is true within certain limits, but practicability of application and finishing costs limit the thickness of film that can be applied.

Let me close by saying that the lacquer manufacturer welcomes the suggestions and discussions of the plater on this latter problem or any others that they are mutually interested in solving. Feel free to give your thoughts to the manufacturer of finishing products and he in turn will be in a position to better meet your varied requirements.

BRANCH NEWS

ANDERSON BRANCH

Anderson branch, A. E. S., held their regular monthly meeting Monday evening, August 1st, at the Guide Lamp Shack. Due to several important forms of entertainment, the business meeting was not called to order.

The committee composed of Mr. James Minton as chairman, Mr. Fred Hammond, Mr. Chet Wilson, and Mr. Ward Taylor arranged a very fine party. Members and guests assembled about five o'clock, with a strenuous horseshoe pitching contest starting off the evening. Bill Castell, our librarian, was acclaimed the outstanding performer. About six-thirty the committee adorned the table with food quite appropriate for the occasion. To assist in the digestion of our food, we enjoyed the strains of familiar music supplied by three of Anderson's Radio Stars, also accompanied by the singing of Ed Kaegi, Fred Hammond and one of our guests. However, before the evening was over several more guests and members contributed to the cause by lending their enchanting voices to the choir. Further, several, not taken for or by music, found their enjoyment in playing cards. The results of the card game were not recorded by the secretary, as he was the more inclined towards singing. It was agreed to adjourn at nine-thirty, so at that time the doors were locked and everyone agreed that the party had been a success.

G. S. Cole, *Secretary.*

LOS ANGELES BRANCH

Meeting at Roslyn Hotel on August 10, 1932, was called to order by President Ben Foss. Frank Rushton made a speech presenting a pen set from the Branch to E. R. Francis, our retiring president. The minutes of June 8th meeting and the financial report were read and accepted.

The Branch authorized Frank Rushton to buy an Olympic Program to be autographed by all members of the Branch and sent to Mr. E. J. Wright, our member in Australia.

Letters from Kocour & Co., and from Mr. Lupean were read. Also letter from Mr. Hansjosten. The secretary was authorized to write Mr. Hansjos-

ten for a report of the convention at which he was a delegate. Bills were read and ordered paid.

The Branch voted to accept the resignations of Mr. Morris and Mr. Robinson and Mr. Lewis. Mr. Whitman was suspended. Secretary was instructed to write letters of notification to resigning member. A committee consisting of Messrs. Rushton, Delaney, Lamoureux, Thornton, Rynkoffs, Foss and Coffin was appointed to call on delinquents and try and collect back dues.

Mr. Lamoureux told of efforts that were being made to have THE REVIEW published monthly as before, instead of quarterly as decided at the Philadelphia Convention. A committee consisting of Messrs. Rynkoffs, Lamoureux, Rushton, Francis, Thornton, Robertson, Foss and Coffin was appointed to act for the Branch, in case any action was necessary before our next meeting.

It was voted that the Entertainment Committee be allowed to decide on the dates of future card parties.

Mr. Ed. Cushing was elected Sergeant at Arms to take the place of Mr. Robinson who resigned.

The secretary was authorized to use post cards for meeting announcements in order to cut down expenses.

Members were instructed to notify the secretary if they cared to attend the chemistry class next term.

The meeting was turned over to the librarian, Mr. Hurd, who read a paper on Rhodium Plating by Mr. H. A. Gilbertson.

The following questions were found in the red box:

Question—What causes dark nickel deposits?

Answer—Copper or zinc in solution, or solution too alkaline. Have it analyzed.

Question—When oxidizing articles plated in cyanide copper, I have trouble with finger marks showing. I do not have this trouble when articles are plated in acid copper. Why?

Answer—Probably the water was dirty. Try dipping hands in the oxidizing solution while handling work.

Question—How would you make a yellow waxed finish on red brass such as is used on bronze doors?

Answer—Hang in potash until stained and then scratch brush.

Question—Which will give the best results, rolled or cast nickel anodes?

Answer—Rolled. If they do not wear away fast enough, add chloride to solution.

The meeting was adjourned.

EARL COFFIN, *Secretary and Treasurer.*

MILWAUKEE BRANCH

The regular meeting of Milwaukee Branch A. E. S. was held on September 8, 1932, at Lipps Hall. President Paul Krause called the meeting to order.

Vacation time is over, but very little plating work is available for most of our members. We are again ready to start the educational work for the winter. We generally start the winter work with a smoker for the members, as this most generally gives us a good attendance, and we can get the boys'

opinions of what they want. This year the smoker will have to be cut out, as we have no funds. Our Branch had a nest egg to be used for emergency, this is tied up in a Building and Loan investment, and our cash was in a bank that closed, and now we are broke.

We are in doubt as to whether we will be able to continue our chemistry class. Most of the members approached feel they cannot afford to attend. Our Vice-President, Robert Shaffer, has a plan for our educational meetings. To make them more interesting, and to get more members to take an active interest in the educational program, the plan is for the President to appoint a committee of three to work with the Librarian and Assistant Librarian, they to decide on the topic for the following month. One of the three appointed members is to drop out each month, and a new member be appointed in his place. This will give all members a chance, and help make our educational meetings more interesting, and work towards a better attendance.

FRANK J. MARX, *Secretary.*

BRIDGEPORT BRANCH

The regular meeting of the Bridgeport Branch was held on July 1 at the Chamber of Commerce rooms in the Stratfield Hotel. There were twelve members in attendance, who were called to order by the President, Mr. Wagstaff.

The minutes of the June meeting were read and accepted. The sick committee reported the illness of Mr. B. Moran to be the only one that they knew of and he was reported to be doing well. There was a lengthy discussion concerning the Outing to be held on September 17 and the chair called for a Special Meeting of that committee for Friday, July 15. A report of the Secretary-Treasurer for the fiscal year was read and it was voted to place this report on file. There were no applications for membership.

All meetings of this branch are to be held on the first Friday of each month and the suggestion was made that the meetings will prove interesting if members will strive to ask questions.

A motion was made and seconded that all bills be paid. It was also decided upon that in the future all bills are to be signed by the Board of Managers or by one member of the Board and the President. The meeting was then adjourned about 9:45 p.m.

On July 15 the Outing Committee, George Knecht, Howard Rice, Ben Kusterer, William Ehrencrona, Al Rosenthal and George Wagstaff, met to further plans for the Outing. The committee had already made plans for serving steaks and producing entertainment. It was voted upon that final arrangements would be made on August 5 at a special meeting.

The meeting adjourned at 9:30.

The regular meeting of the Bridgeport Branch was held on July 22 at the Chamber of Commerce rooms in the Stratfield Hotel. There were eighteen members in attendance and four officers absent.

The minutes of the last meeting were read and accepted. The minutes of the meeting concerning the Outing were also read and accepted. The

Sick, Standing and Special Committees had no reports to make. Resignations of A. M. Theirault and C. Altermath were read and accepted with regret. There were no applications for membership.

New Business: Members were informed of the Outing at Koch Farm on Saturday, September 17, 10 a.m. to 9 p.m. The Secretary was instructed to send cards to the members.

Meeting adjourned at 9:30 p.m.

Instead of a regular meeting on September 2 a Round Table discussion was held until 10:30 p.m.

On September 9 there was a meeting of the Outing Committee to make final arrangements for the Outing. It was voted to allow the wives of members to attend the Outing without additional charge. In case of rain the Outing will be postponed until the following day.

Respectfully submitted,

WM. FLAHERTY, *Secretary.*

NEWARK BRANCH

The Newark Branch held its regular meeting on Friday evening and Mr. George Wagner, chairman of fishing trip to Forked River, reported a fine time for all who attended.

On Saturday, September 10, the Newark Branch held its first clambake at Vogel's Grove. With an attendance of one hundred a wonderful time was had by all. Beginning at 10 our refreshments and hot sandwiches, clams on the half shell and clam broth were served all day long, during which time there was a ball game between Rivals and Revivals. The score was 3 to 2, with President Harrison playing a sensational game at short for the winners and scoring the winning run. There was a 50-yard dash for the ladies, as well as a rope-skipping contest and then the big meal of chicken, lobster, corn, sweet potatoes and—oh what a meal! Again Mr. Smith and Mr. Sizelove gave the Newark members something to talk about for a long while to come.

GEORGE REUTER, *Secretary.*

CHICAGO BRANCH

The regular monthly meetings of Chicago Branch A. E. S. were held Saturday, July 9, and September 10, 1932, at the Atlantic Hotel, with President Frank Hanlon presiding and all other officers present.

There was no meeting held in August. We had with us at our July meeting our honorary member, Mrs. Dr. E. Gailley, who acted as our librarian for the evening. President Frank Hanlon, delegate to the Philadelphia Convention, read a very interesting report on what took place at our annual convention. Chicago was unanimously chosen as the meeting place for the 1933 Convention.

At our September meeting President Frank Hanlon appointed our convention committees. The committees and their chairmen are as follows: The Executive Committee is composed of Branch officers and the chairmen of all the committees with President Hanlon as chairman, Mr. H. A. Gilbertson, treasurer, and C. S. Tompkins, secretary. Educational Committee, Oscar

Servis, chairman; Publicity Committee, H. W. Faint, chairman; Finance Committee, C. E. Clindinin, chairman; Entertainment Committee, C. E. Stiers, chairman; Plant Visitation Committee, F. W. Greenwald, chairman; Reception Committee, R. Myers, chairman; Transportation Committee, Nathan Hunter, chairman; Exhibit Committee, J. C. Kretschman, chairman.

The meeting was turned over to the Librarian, Mrs. Dr. Gailley, who found the following questions in box.

Question—What is the best pickle for removing fire scale on steel, that has been brazed, and bring it out bright be it electro or dip pickle?

Answer—Use nitre cake electro-pickle.

Question—What impurities are present in rolled copper anodes? Which ones are likely to cause uneven wear of the anodes?

Answer—No definite answer was given, but the suggestion was made that occasionally some arsenic might be present.

Question—What causes a brass to plate sandy when either water or cyanide is added? The sandy effects are of a white substance.

Answer—It was thought to be far too rich in metal. Suggest diluting solution with equal amount of water, then adjust free cyanide.

Question—How much does chromium plate aid nickel in resisting salt spray corrosion?

Answer—There is wide difference of opinion with arguments backed by salt spray tests—but no final proof either way.

Question—What kind of a solution and cleaner is best to use for die-casting that has to be chromium plated, buffed?

Answer—Any mild patent cleaner, or a formula of 2-oz. sodium carbonate and 1-oz. trisodium phosphate per gallon of water.

Question—What is cause of minute roughness in copper cyanide, strike plating Cu. 15N, total alkali 7N, free cyanide 25N?

Answer—No answer given. Have any other branches the solution?

Question—Is it necessary to copper plate brass or soldered parts before tin plating?

Answer—It may not be necessary, but is considered good practice in production.

Question—Of what value is iron deposition in the plating industry?

Answer—It is very satisfactory finish for many articles, and has proven its value against frictional wear in many mechanical applications.

E. G. STENBERG, *Secretary.*

WATERBURY BRANCH

The September meeting of Waterbury Branch was of short duration, due to the small attendance. This condition was evidently caused by the warm weather.

Tennant Elwin, newly elected president, has expressed a desire that all members who possibly can, attend the next meeting which takes place Friday evening, October 14th, at Engineers Hall, 11 East Main St. It is expected that information of vital importance to every member of the Branch will be imparted at this meeting. Plans for fall and winter activities will be

discussed, and an expression of opinion as to the make-up of ideal programs will be appreciated. Librarian Joseph McConas and his assistant, Ellsworth Candee, will arrange for a series of talks by speakers that will be instructive and interesting.

WM. F. GUILFOILE, *Secretary.*

APPLICATIONS

DANIEL BAUMANN, 268 Nesbit Terrace, Irvington, N. J. .....Newark
JOHN B. KOTCHES, 244 Westfield Ave., Elizabeth, N. J. .....Newark
W. PISCHL, 94 Jacoby St., Maplewood, N. J. .....Newark
ARTHUR WALLACE, 209 W. 38th St., New York, N. Y. .....New York

RESIGNATIONS

M. DANZ, 2829 4th St., Peru, Ill. .....Chicago
G. M. ELLIOTT, Belvidere, Ill. .....Chicago
G. HENRY, Wilmette, Ill. .....Chicago
P. IRLBACKER, 4101 W. 25th St., Chicago, Ill. .....Chicago
F. SHERMAN, 507 E. 6th Ave., Saint Charles, Ill. .....Chicago

SUSPENSIONS

J. COMFORT, 116 Garden St., Bellville, N. J. .....Newark
F. DONDI, 94 21st St., Irvington, N. J. .....Newark
E. L. FISH, Box 228, Milton, Wis. .....Chicago
A. B. GORK, 1520 Price St., Rockford, Ill. .....Chicago
F. J. HERBERT, 2023 Grace St., Chicago, Ill. .....Chicago
G. HILGER, 901 Cotton St., Streator, Ill. .....Chicago
W. HULTS, 23 S. Mountain Rd., Milburn, N. J. .....Newark
T. J. KEATING, 53 Ellington St., E. Orange, N. J. .....Newark
O. G. KISTLER, 1414 Johnson St., Elkhart, Ind. .....Chicago
A. KING, 23 Franklin St., Newark, N. J. .....Newark
G. MCGANN, 55 S. 20th St., E. Orange, N. J. .....Newark
E. MCLAUGHLIN, 381½ Springfield Ave., Newark, N. J. .....Newark
F. OLSEN, 511 Park Ave., Brooklyn, N. Y. .....Newark
A. H. SCHNERING, 822 S. 18th St., Newark, N. J. .....Newark
J. STEIN, 140 West End Ave., Newark, N. J. .....Newark
J. VAN ZANDT, Park Ave., Scotch Plains, N. J. .....Newark

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MR. W. S. BARROWS.....628 Dovercourt Road, Toronto, Canada

C. F. NIXON.....Ternstedt Manufacturing Co., Detroit

DR. H. S. LUKENS.....University of Pennsylvania, Philadelphia, Pa.

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Anderson Branch.....D. A. COTTON

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Other Branch Representatives will be printed as received.